

Having described the invention as above, we claim:

1. A glass composite comprising:

a first phosphate glass surface;

5 a second phosphate glass surface; and

between and in contact with said surfaces, a phosphorus-containing solution.

2. A glass composite as claimed in claim 1, wherein the phosphorus-containing solution is an aqueous solution.

10 3. A glass composite as claimed in claim 1, wherein the phosphorus-containing solution is an aqueous solution of phosphoric acid.

4. A glass composite as claimed in claim 3, wherein the aqueous solution of phosphoric acid contains phosphorus equivalent to an amount of from 0.1 to 85 weight % of  $P_2O_5$ .

5. A glass composite as claimed in claim 4, wherein the aqueous solution of phosphoric acid contains phosphorus equivalent to an amount of from 0.1 to 30 weight % of  $P_2O_5$ .

20 6. A glass composite as claimed in claim 5, wherein the aqueous solution of phosphoric acid contains phosphorus equivalent to an amount of from 0.1 to 20 weight % of  $P_2O_5$ .

7. A glass composite as claimed in claim 6, wherein the aqueous solution of phosphoric acid contains phosphorus equivalent to an amount of from 10-20 weight % of  $P_2O_5$ .

8. A glass composite as claimed in claim 1, wherein the solution is acidic.

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9. A glass composite as claimed in claim 1, wherein the solution is basic.

10. A glass composite as claimed in claim 9, wherein the solution contains alkali or alkaline earth elements.

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11. A glass composite as claimed in claim 8, wherein the solution contains phosphoric acid.

12. A glass composite as claimed in claim 1, wherein the solution comprises:

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water in an amount of from about 15-99.9 weight %,

phosphorus in an amount equivalent to about 0.1-85 weight %  $P_2O_5$ .

13. A glass composite as claimed in claim 11, wherein the solution comprises

water in an amount of from about 50-90 weight %,

phosphorus in an amount equivalent to about 5-35 weight %  $P_2O_5$ ,

$Na_2O$  in a amount of from about 1-20 weight %,

5  $K_2O$  in an amount of from about 1-20 weight %,

$Al_2O_3$  in an amount of from about 0-5 weight %, and

$SiO_2$  in an amount of from about 0-15 weight %.

14. A glass composite as claimed in claim 11, wherein the solution comprises

10 water in an amount of from about 70-90 weight %,

phosphorus in an amount equivalent to about 10-30 weight %  $P_2O_5$ ,

$Na_2O$  in a amount of from about 1-20 weight %, and

$SiO_2$  in an amount of from about 0-8 weight %.

15 15. A glass composite comprising:

a first phosphate glass interface;

a second phosphate glass interface; and

between and in contact with said interface, a layer comprising a cured phosphorus  
containing solution.

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16. A glass composite comprising:

a first phosphate glass interface;

a second phosphate glass interface; and

between and in contact with said interface, a condensed phosphate layer that links

5 the two interfaces.

17. A glass composite as claimed in claim 16, wherein the condensed phosphate layer is  
a (P-O-P) layer.

10 18. A glass composite prepared by joining two phosphate glass substrates together by  
curing therebetween a phosphorus-containing aqueous solution.

19. A method of bonding two phosphate glass surfaces comprising curing therebetween a  
phosphorus-containing aqueous solution.

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20. A method as claimed in claim 19, further comprising a subsequent heat treatment.

21. A method as claimed in claim 20, wherein the heat treatment occurs at a temperature  
below the glass transition temperature of each phosphate glass surface.

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22. A method as claimed in claim 20, wherein the heat treatment occurs at a temperature  
of from about 60°C to about 550°C.

23. A method as claimed in claim 22, wherein the heat treatment occurs at a temperature of from about 100° C to about 500° C.

24. A method as claimed in claim 23, wherein the heat treatment occurs at a temperature of from about 200° C to about 400° C.

25. A method as claimed in claim 24, wherein the heat treatment occurs at a temperature of from about 350° C to about 400° C.

26. A method as claimed in claim 19, wherein the curing is conducted for at least three days followed by a heat treatment.

27. A method as claimed in claim 19, wherein the curing is conducted for about a week.

28. A method as claimed in claim 27, wherein the curing is followed by a heat treatment.

29. A method as claimed in claim 19, wherein the two phosphate glass surfaces each have surface features equal to or less than 200 nm in height.

30. A method as claimed in claim 29, wherein the two phosphate glass surfaces are each polished.

31. A process for the formation of a phosphate-based glass composite, comprising:

providing a first phosphate-based glass having a first surface and a second  
phosphate-based glass having a second surface,

5 processing said first and second phosphate-based glass surfaces to provide a  
bonding surface,

providing a solution containing a phosphorus compound,

applying said phosphorus compound containing solution to at least one of said  
first and second phosphate-based glass surfaces,

10 placing said first surface into contact with said second surface, and  
retaining said surfaces in contact until said surfaces are joined together while the  
composite cures.

32. A process as claimed in claim 31, further comprising heating the joined surfaces to a  
temperature below the glass transition temperature of the first or second phosphate-based  
15 glass surface.

33. A process as claimed in claim 31, wherein a vacuum is applied while the composite  
cures.

20 34. A process as claimed in claim 31, wherein the process is conducted at about room  
temperature.

35. A process as claimed in claim 31, wherein said step of processing said first and second phosphate-based glass surfaces comprises grinding or polishing.

36. A process as claimed in claim 35, wherein the resulting surface has a surface feature  
5 of less than 200 nm.

37. A process as claimed in claim 31, further comprising, after the step of processing, cleaning said first and second processed surfaces.

10 38. A process as claimed in claim 31, wherein pressure is applied to the phosphate-based glass surfaces.

39. A process as claimed in claim 31, wherein the temperature of the phosphate-based glass surfaces is gradually raised during the step of retaining.

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40. In a photonic device comprising a phosphate glass component, the improvement wherein said phosphate glass component is a glass composite of claim 2.

41. A photonic device as claimed in claim 40, wherein the photonic device is a multiple-  
20 wavelength laser array.

42. A photonic device as claimed in claim 41, wherein the photonic device is a low-loss splitting device.

43. A photonic device as claimed in claim 42, wherein the photonic device is a self-cooling laser.

5 44. A phosphate glass having a phosphorus treated surface, comprising  
a phosphate glass substrate, said phosphate glass substrate having a surface  
feature of less than about 200 nm, and  
a layer of phosphorus-containing solution applied thereto.

10 45. A phosphate glass as claimed in claim 44, further comprising a ceramic sandwiching  
the phosphorus-containing solution.

46. A phosphate glass as claimed in claim 44, further comprising a non-phosphate glass  
sandwiching the phosphorus-containing solution.

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